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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is included. (AG)

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U.S. Training and Employment Service Technical Report S-111R

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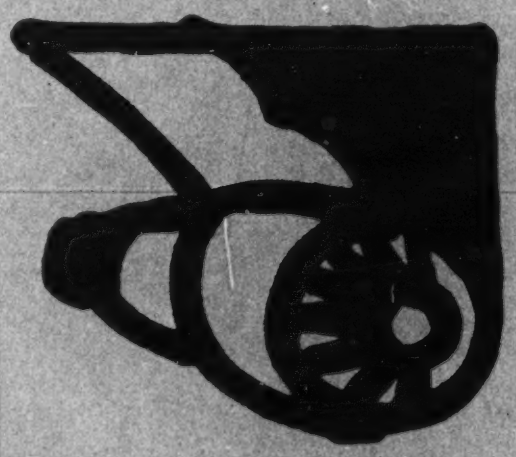
Development of USTES

APTITUDE TEST BATTERY FOR

AIRCRAFT-AND-ENGINE MECHANIC

(aircraft mfg; air trans.)
621.281

U.S. DEPARTMENT OF LABOR
Manpower Administration



Technical Report on Development of USTES Aptitude Test Battery

For . . . .

Aircraft-And-Engine Mechanic (aircraft mfg.; air trans.) 621.281

S-111R

(Developed in Cooperation with the
Wisconsin State Employment Service)

U. S. Department of Labor
Manpower Administration

June 1970

FOREWORD

The United States Training and Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores foe each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

GATB Study #2593

DEVELOPMENT OF USTES APTITUDE TEST BATTERY

For

Aircraft-And-Engine Mechanic (aircraft mfg.; air trans.) 621.281-010

S-111R

This report describes research undertaken for the purpose of determining General Aptitude Test Battery (GATB) norms for the occupation of Aircraft-and-Engine Mechanic (aircraft mfg.; air trans.) 621.281. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB Scores
N - Numerical Aptitude	90
S - Spatial Aptitude	100
F - Finger Dexterity	85

RESEARCH SUMMARY

Sample:

75 male students at the Janesville and Milwaukee, Wisconsin Vocational Technical and Adult Schools. This study was conducted prior to the requirement of providing minority group information. Therefore, minority group status is unknown.

Criterion:

Grade point average.

Design:

Longitudinal (test data collected at the beginning of the school term and criterion data collected upon completion of the term.)

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations and selective efficiencies.

Predictive Validity:

Phi coefficient = .41 (P/2 .0005)

Effectiveness of Norms:

Only 68% of the non-test-selected students used for this study were good students. If the students had been test-selected with the above norms, 79% would have been good students. 32% of the non-test-selected students used for this study were poor students; if the students had been test-selected with the above norms only 21% would have been poor students. The effectiveness of the norms is shown graphically in Table 1.

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Students	68%	79%
Poor Students	32%	21%

SAMPLE DESCRIPTION

Size:

N = 75

Occupational Status:

Students

Type of School:

Vocational, Technical and Adult Schools Janesville and Milwaukee, Wisconsin

School Selection Requirements:

Education: Prefer twelfth grade - service training may be substituted for lack of high school diploma.

Previous Experience: None

Tests: None

TABLE 2

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age and Education

	Mean	SD	Range	r
Age (years)	23.2	4.4	18-46	.030
Education (years)	12.0	.7	9-14	-.186

All 12 tests of the GATB, B-1002B, using the IBM Separate Answer Sheets were administered between July 1963 and October 1964 at the beginning of four separate terms.

CRITERION

The criterion data consisted of the average grade obtained for 17 required subjects converted to grade point averages, and multiplied by 100 to eliminate the decimal.

Reliability: Since only one final grade was obtained for each subject, no measure of criterion reliability is available.

Criterion Distribution:		
	Range:	71-370
	Mean:	251
	Standard Deviation:	59

Criterion Dichotomy: The criterion distribution was dichotomized into low and high groups by placing 32% of the sample in the low group to correspond with the percentage of students considered below average. Students in the high criterion group were designated as "good students" and those in the low group as "poor students." The critical cutting score is 223.

APTITUDES CONSIDERED FOR INCLUSION IN THE TEST NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitudes S and M which do not have a high correlation with the criterion were considered for inclusion in the norms because the qualitative analysis indicated that they were important for the job duties and the sample had a relatively high mean score for these aptitudes. Aptitude F was considered for inclusion in the norms because the qualitative analysis indicated that it was of supreme importance for the job duties involved and although it did not meet the usual requirements for inclusion (relatively high mean or relatively low standard deviation), it did have the fourth highest mean score for the sample and it also had a standard deviation of less than 15, indicating a considerable amount of restriction. Tables 3, 4 and 5 show the results of the qualitative and statistical analysis.

TABLE 3

Qualitative Analysis
(Based on the job analysis, the aptitudes indicated appear to be important to the work performed)

Aptitude	Rationale
G - General Learning Ability	Necessary to understand the subject matter of the curriculum and to learn the procedures of airplane repair and maintenance; to use judgment in determining malfunctioning of engine and to follow manufacturers specifications in making repairs.
S - Spatial Aptitude	Necessary to read and interpret diagrams and drawings used in such course subjects as Aircraft Drawing and Structures and Engine Assembly and Disassembly; to use damaged parts for patterns to make metal patchs; and to bend parts to shape by hand.
P - Form Perception	Necessary to make visual inspection of aircraft parts and to check fit of parts in order to determine if adjustments, repairs or replacements are necessary.
F - Finger Dexterity	Necessary to skillfully manipulate a variety of small hand tools to remove small parts and fastening devices and to connect and disconnect electrical wiring to assemble and disassemble aircraft.
M - Manual Dexterity	Necessary to move hands and wrists easily to use necessary tools and make necessary preparations to dismount engines and to install overhauled and new engines.

TABLE 4

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB

Aptitude	Mean	SD	Range	r
G - General Learning Ability	113.2	13.6	81-154	.406**
V - Verbal Aptitude	104.6	11.4	82-137	.354**
N - Numerical Aptitude	106.7	12.2	77-132	.341**
S - Spatial Aptitude	119.9	17.2	74-166	.223
P - Form Perception	106.3	14.7	78-158	.078
Q - Clerical Perception	106.4	14.0	76-141	.181
K - Motor Coordination	102.7	15.4	70-149	.011
F - Finger Dexterity	107.1	13.8	76-145	.110
M - Manual Dexterity	119.6	19.8	78-178	-.138

** Significant at the .01 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	X			X	X			X	X
Irrelevant									
Relatively High Mean	X			X					X
Relatively Low Standard Dev.	X	X	X						
Significant Correlation with Criterion	X	X	X						
Aptitudes to be Considered for Trial Norms	G	V	N	S				F	M

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of Aptitudes G, V, N, S, F, and M at trial cutting scores were able to differentiate between the 68% of the sample considered good students and the 32% of the sample considered poor students. Trial cutting scores at five point intervals approximately one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For two-aptitude trial norms, minimum cutting scores of slightly higher than one standard deviation below the mean will eliminate about one-third of the sample; for four-aptitude trial norms, cutting scores of slightly lower than one standard deviation below the mean will eliminate about one-third of the sample. The phi coefficient was used as a basis for comparing trial norms. Norms of N-90, S-100, and F-85 provided optimum differentiation. The validity of these norms is shown in Table 6 and is indicated by a phi coefficient of .41 (statistically significant at the .0005 level).

TABLE 6

Predictive Validity of Test Norms
N-90, S-100 and F-85

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Students	5	46	51
Poor Students	12	12	24
Total	17	58	75

Phi coefficient (ϕ) = .41 Chi square (X^2_y) = 12.8
Significance level = P/2 .0005

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirements for incorporating the occupation studied into OAP-35 which is shown in Section II of the Manual for the General Aptitude Test Battery. A phi coefficient of .36 is obtained with the OAP-35 norms of N-85, S-95, and F-80.

A-P-P-E-N-D-I-X

Job and Course Descriptions

Course Description: The two semester course of 1670 hours is approved by the Federal Aviation Agency. The curriculum is as follows:

Airframe Subjects

A-150 Aircraft Electricity	60 hours
A-152 Aircraft Structures	180 hours
A-154 C.A.R. and Theory of Flight	23 hours
A-156 Aircraft Welding	120 hours
A-158 Aircraft Drawing	31 hours
A-250 Aircraft Instruments and Radio	60 hours
A-252 Aircraft Hydraulics and Breaks	72 hours
A-254 Aircraft Sheetmetal	109 hours
A-256 Aircraft Maintenance	180 hours
	835 hours

Powerplant Subjects

P-154 Civil Air Regulations	17 hours
P-151 Engine Theory	24 hours
P-153 Engine Assembly and Disassembly	170 hours
P-155 Ignition and Accessories	120 hours
P-158 Aircraft Drawing	31 hours
P-161 Carburetor and Lubrication	60 hours
P-251 Propellers	60 hours
P-253 Engine Overhaul	180 hours
P-255 Engine Operation	173 hours
	835 hours
Total	1670 hours

SUPPLEMENTAL SHEET FOR S-111R TECHNICAL REPORT

Dismantles engine: Strips engine of all remaining accessories, such as ignition wires, spark plugs, magnetos, carburetor, air heater, starter, oil cooler, air tubes, exhaust pipes, intake pipes, fuel pump, and oil pump; removes engine units such as push-rods and housings, valves, crankcase, supercharger, pistons, connecting rods, master rod, crankshaft, and accessorory drive gears and case; dismantles each unit by removing component parts.

Cleans, inspects, tests, adjusts, and repairs engine parts: Cleans all parts in kerosene or other solution, using brushes, rags, and spray gun; inspects each part for wear and checks dimensions against manufacturer's specifications, using micrometers and special gages; detects hidden defects such as cracks and blisters by magnetizing the part with electric current and applying a solution containing particles of iron which cling to damaged areas; may heat parts to expose cracks; resurfaces slightly worn parts by hand with oilstones, files, and abrasive cloth and compounds, or on specially designed grinding machines; anneals metal piping to prevent it from becoming brittle; replaces badly worn parts, tests crankshaft assembly for balance on balancing table, turning shaft slowly against contact point of dial indicator to determine any irregularity in dimensions of alinement; realines crankshaft assembly by placing it in vise and adjusting position of counterweight; mounts propeller on steel shaft (mandrel) and tests it for balance on balancing stand and for pitch angle and track on calibrated table, using a special type of protractor to measure and adjust the angle of pitch; adjusts propeller for track by removing some of metal or wood on one side of hub face, and for balance by shifting bolts and clamps on hub, or by tamping lead wool into holes in base of blades; tests carburetor, cylinders, oil tank, and oil radiator for leakage by filling them with fluid; tests current of starter motor with ammeter, checks turning torque of motor with dynamometer, and adjusts tension of starter clutch; tests starter battery with hydrometer and voltmeter and raises or lowers voltage by adjusting voltage regulator on generator; may test and adjust engine instruments.

Assembles, checks, and times engine: Assembles engine in reverse order of dismantling, lubricates moving parts and checks clearance of all moving parts with special gages or micrometer; inspects installation of all parts and checks tightness of nuts and bolts with torsion wrench; checks synchronization of dual magneto ignition system with timing light; times engine by regulating valves and distributor points so that they operate at the proper time in relation to the position of pistons; may test overhauled engine on a stand.

FACT SHEET

Job Title

Aircraft- And Engine Mechanic (aircraft mfg.; air trans.) 621.281-010

Job Summary

Services, repairs, overhauls, and inspects airplanes and airplane engines, using hand and machine tools and testing equipment.

Work Performed

Examines airplane parts, testing tightness of connections, checking fit of parts, and operating controls to determine required adjustment, repair, or replacement.

Disconnects control cables, fuel lines, electrical wiring, and fastening devices such as hinger, clamps, and bolts, using handtools. Attaches lifting crane to center of wing, unscrews bolts on fairings, and lifts wing assembly from plane using crane.

Releases wires and control cables from rudder and elevator, and disconnects attachments which fasten various members together or to fuselage. Supports fuselage on jacks and removes landing-gear parts. Attaches chain hoist to engine for support, disconnects fuel lines and engine controls, and unbolts engine mount from fire wall to remove engine from fuselage.

Trims cracks and holes in metal surface, using hand snips; and smoothes edges, using chisel or file. Cuts patch, using band saw or ring and circle shears, using damaged parts for pattern. Drills rivet holes in patch and corresponding holes in surface metal, using electric drill, and rivets patch over hole, using pneumatic riveting hammer or hand hammer and bucking block. Cuts copper tubing with hacksaw, bends tubing to shape, and bolts new tubing in place to replace damaged fuel lines. Cuts damaged control cables at nearest turnbuckle and replaces with new cable. Religns brakes, installs wheel-bearings, aligns wheels, repairs tires, replaces damaged springs and hydraulic cylinders, and repairs struts, according to manufacturer's specifications. Repairs metal structural members such as ribs, spars, and stringers, using riveting and welding tools.

Inflates tires, fills gasoline tanks and changes oil; and lubricates fittings, using grease gun. Cleans mechanical parts, using rags, cleaning fluid, and air hose.

Disconnects wires and accessories from engine, fastens chain hoist to engine and lifts engine from airplane for overhauling. Removes all remaining accessories, such as carburetor, air heater, starter, oil cooler, fuel pump, and oil pump; and removes engine units, such as push-rods and housings, valves, crankcase and crankshaft, pistons, and accessory drive gears and case, using mechanics tools. Cleans parts in kerosene or other solution. Inspects parts for wear, using micrometers and special gauges. Re-surfaces slightly worn parts by hand with oil stones, files, and abrasive cloth and compounds, or on specially designed grinding machines. Replaces badly worn parts. Tests crankshaft assembly for balance on balancing table, and adjusts position of counter weight to realine crankshaft. Tests carburetor, cylinders, oil tank, and oil radiator for leakage by filling them with fluid. Tests current of starter motor with ammeter, checks turning torque of motor with dynamometer, and adjusts tension of starter clutch. Tests starter battery with hydrometer and voltmeter, and raises or lowers voltage by adjusting voltage regulator or generator. Reassembles engine, lubricates moving parts, and inspects installation of parts. Regulates valves and distributor points to time engine. Clears engine mount, replaces worn clamps, brackets, wiring, and bonding attached to mount. Re-installs overhauled engine, using handtools and chain hoist. Starts engine and observes reading of instruments to verify accuracy of repair and installation.

Effectiveness of Norms

Only 68% of the non-test-selected students used for this study were good students; if the students had been test-selected with the S-111R norms, 79% would have been good students. 32% of the non-test-selected students used for this study were poor students; if these students had been test-selected with the S-111R norms, only 21% would have been poor students.

Applicability of S-111R Norms

The aptitude test battery is applicable to jobs which include a majority of duties described above.

GPO 898.705

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